



Standard Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties¹

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1. Scope

1.1 This test method covers the measurement of the apparent viscosity of shear-rate-dependent adhesives.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

- 2.1 *ASTM Standards:*
D 907 Terminology of Adhesives²

3. Terminology

3.1 *Definitions:* Many terms in this test method are defined in Terminology D 907.

3.1.1 *Newtonian behavior, n*—the property of a liquid in which its viscosity is constant over a stated range of strain rates. (Compare *non-Newtonian behavior*.)

3.1.2 *non-Newtonian behavior, n*—the property of a liquid in which its viscosity is not constant over a stated range of strain rates.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent viscosity, n*—resistance to shear at a given rate of shear, expressed as viscosity in absolute units.

4. Significance and Use

4.1 The principle of measurement is based upon a reversible isothermal change in apparent viscosity with change in rate of shear.

4.2 Measurement is performed with a spindle, disk, T-bar, or coaxial cylinder rotational viscometer under standardized conditions with rigid control of the time intervals of measurement. Readings are obtained on the viscometer dial scale at the end of 1 min for each rotational speed. Changes from the lowest speed to the highest speed, and return to the lowest speed, are made without stopping the instrument.

5. Apparatus

5.1 *Viscometer*—The apparatus consists of a spindle,³ disk,³ T-bar,³ or coaxial-type⁴ viscometer with appropriate spindles, disks, T-bars, or cylinders. Do not use a scored, warped, or otherwise damaged spindle, disk, T-bar, or cylinder. Except when using the coaxial cylinder-type viscometer, the size of container to be used is determined by mutual agreement. Some instruments have two concentric scales, and care is to be taken to read the pointer on the correct scale.

5.2 *Supporting Stand*⁵—Use a support for the viscometer which consists of a suitable stand with a supporting arm capable of being lowered or raised either manually or mechanically.

5.3 *Thermometer*— Use a precision thermometer, with graduations not greater than 0.2°C (0.5°F), for temperature measurements.

6. Conditioning

6.1 Condition the adhesive sample and instrument at $23 \pm 0.5^\circ\text{C}$ ($73.4 \pm 1.0^\circ\text{F}$) (or other temperature agreed upon between the adhesive vendor and the purchaser) at least 16 h. If special conditioning methods are necessary, such as the use of a circulating water bath, they shall be noted in the report, see 8.1.4.

7. Procedure

7.1 Select a viscometer and spindle (see Table X1.1), disk, T-bar, or cylinder suited to the viscosity range of the material such that the model-speed-rotational element combination will give dial readings between 20 and 80 % of the full-scale reading. Firmly fit the rotational element into the shaft extension which goes down through the center of the dial casing. Place the viscometer on the supporting stand so that the rotational element is vertical. Slowly immerse the rotational element in the sample to the depth recommended by the

³ The Brookfield Synchro-Lectric Viscometers, Models LV, RV, or HV have been found satisfactory for this purpose and are available from the Brookfield Engineering Laboratories, Stoughton, MA.

⁴ The Ferranti Portable Viscometers, Models VL, VM, or VH have been found satisfactory for this test method and are available from Ferranti Electric Inc., Plainview, Long Island, NY.

⁵ The Brookfield Helipath Stand or other commercially available stands may be used.

¹ This test method is under the jurisdiction of ASTM Committee D-14 on Adhesives and is the direct responsibility of Subcommittee D 14.10 on Working Properties.

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² *Annual Book of ASTM Standards*, Vol 15.06.

manufacturer of the apparatus or, where this is not clearly indicated, to a depth agreed upon between the adhesive vendor and the purchaser. Take care as the rotational element is lowered into the solution to ensure that no air is trapped under or around it. See Appendix X1 for example of spindle selection.

7.2 With the rotational element immersed in the adhesive, start the motor of the viscometer at the lowest rotational speed. Maintain this speed for exactly 1 min. Without stopping the motor, increase the speed to the next indicated measure of rotation, etc., at 1-min (± 2 s) intervals, until the maximum readable rotation has been achieved. At the end of 1 min at this speed, decrease the revolutions per minute in 1-min intervals until the lowest speed has been reached. Record dial readings at the end of each minute.

7.3 A plot of rotational speed versus apparent viscosity as determined from the dial readings provides evidence as to shear-rate dependency of the material. A value of apparent viscosity may be obtained from any point on the curve.

8. Report

8.1 Report the following information:

8.1.1 Date of test and complete identification of the adhesive tested, including type, source, manufacturer's code numbers, form, date of manufacture,

8.1.2 Name and model number of the instrument used,

8.1.3 Number and type of rotational element used,

8.1.4 Conditioning procedure employed in preparation of the adhesive for testing, including dimensions of the test container,

8.1.5 Time elapsed between various operations in preparation of the adhesive mix and between rotational element immersion and start of test,

8.1.6 Temperature of the sample during test,

8.1.7 Depth of immersion of rotating element (if depth not standard), and

8.1.8 Apparent viscosity in poises or equivalent units associated with the particular equipment at one or more selected rotational speeds and whether obtained while increasing or decreasing the rotational speeds.

NOTE 1—The shear-rate-dependent characteristics of a sample under test may be defined by a so-called “thixotropic index,” which is the ratio of apparent viscosities at two different speeds. For example:

$$\frac{\text{apparent viscosity at speed 2}}{\text{apparent viscosity at speed 20}} = 80\,000 \text{ cP} / 20\,000 \text{ cP} = 4 \quad (1)$$

9. Precision and Bias

9.1 No precision and bias data are available for this test method.

10. Keywords

10.1 apparent viscosity

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE OF TABLE FOR VISCOMETER AND SPINDLE SELECTION

TABLE X1.1 Recommended Spindles for Brookfield RVF Viscometer

Range, cP ^A	Spindle	Speed, r/min	Factor ^B
100 to 400	1	20	5
400 to 800	1	10	10
800 to 1 600	2	20	20
1 600 to 3 200	2	10	40
3 200 to 4 000	3	20	50
4 000 to 8 000	4	20	100
8 000 to 16 000	4	10	200
16 000 to 20 000	3	4	250
20 000 to 40 000	4	4	500
40 000 to 80 000	4	2	1 000
80 000 to 160 000	5	2	2 000
160 000 to 200 000	6	4	2 500
200 000 to 400 000	6	2	5 000
400 000 to 800 000	7	4	10 000
800 000 to 2 000 000	7	2	20 000

^A If the scale reading is below 20 or above 80, move to the spindle and speed recommended for the next lower or higher viscosity-range.

^B To obtain the viscosity in centipoises, multiply the reading on the “100” scale by the factor for the given spindle and speed.



REFERENCES

- (1) Eirich, F. R., *Rheology*, Academic Press, 111 5th Ave., New York, NY, 1960. (2) Green, Henry, *Industrial Rheology and Rheological Structures*, John Wiley and Sons, New York, NY, 1949.

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